

BIOMOLECULES

4.0 INTRODUCTION :

Complex organic compound which governs the common activities of the living organism are called biomolecules. Living systems are made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc. In addition, some simple molecules like vitamins and mineral salts also play an important role in the functions of organisms.

4.1 CARBOHYDRATES

Carbohydrates are primarily produced by plants and form a very large group of naturally occurring organic compounds. Some common examples are cane sugar, glucose, starch, etc. Most of them have a **general formula, $C_x(H_2O)_y$** , and were considered as hydrates of carbon from where the name carbohydrate was derived. For example, the molecular formula of glucose ($C_6H_{12}O_6$) fits into this general formula, $C_6(H_2O)_6$. **But all the compounds which fit into this formula may not be classified as carbohydrates. Rhamnose, $C_6H_{12}O_5$ is a carbohydrate but does not fit in this definition.** Chemically, *the carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.* Some of the carbohydrates, which are sweet in taste, are also called sugars. **The most common sugar, used in our homes is named as sucrose whereas the sugar present in milk is known as lactose.**

4.1.1 Classification of Carbohydrates :

Carbohydrates are classified on the basis of their behaviour on hydrolysis. They have been broadly divided into following three groups.

(i) Monosaccharides :

A carbohydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone is called a **monosaccharide**. Some common examples are glucose, fructose, ribose, etc.

Monosaccharides are further classified on the basis of number of carbon atoms and the functional group present in them. If a monosaccharide contains an aldehyde group, it is known as an **aldose** and if it contains a keto group, it is known as a **ketose**. Number of carbon atoms constituting the monosaccharide is also introduced in the name as is evident from the examples given in Table

Different Types of Monosaccharides

Carbon Atom	General term	Aldehyde	Ketone
3	Triose	Aldotriose	Ketotriose
4	Tetrose	Aldotetrose	Ketotetrose
5	Pentose	Aldopentose	Ketopentose
6	Hexose	Aldohexose	Ketohexose
7	Heptose	Aldoheptose	Ketoheptose

(ii) Oligosaccharides :

Carbohydrates that yield two to ten monosaccharide units, on hydrolysis, are called oligosaccharides. They are further classified as disaccharides, trisaccharides, tetrasaccharides, etc., depending upon the number of monosaccharides, they provide on hydrolysis. Amongst these the most common are disaccharides. The two monosaccharide units obtained on hydrolysis of a disaccharide may be same or different. For example, sucrose on hydrolysis gives one molecule each of glucose and fructose whereas maltose gives two molecules of glucose only.



(iii) Polysaccharides :

Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, etc. Polysaccharides are not sweet in taste, hence they are also called **non-sugars**.

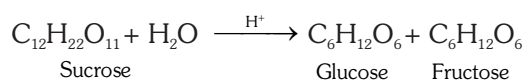
The carbohydrates may also be classified as either reducing or non-reducing sugars. All those carbohydrates which reduce Fehling's solution and Tollens' reagent are referred to as reducing sugars. All monosaccharides whether aldose or **ketose are reducing sugars**.

In disaccharides, if the reducing groups of monosaccharides i.e., aldehydic or ketonic groups are bonded, these are **non-reducing sugars e.g. sucrose**. On the other hand, sugars in which these functional groups are free, are called reducing sugars, for example, maltose and lactose.

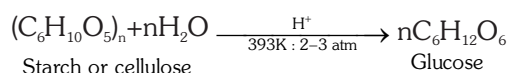
4.1.2 GLUCOSE (ALDOHEXOSE)

Preparation of Glucose

1. **From sucrose (Cane sugar):** If sucrose is boiled with dilute HCl or H₂SO₄ in alcoholic solution, glucose and fructose are obtained in equal amounts.

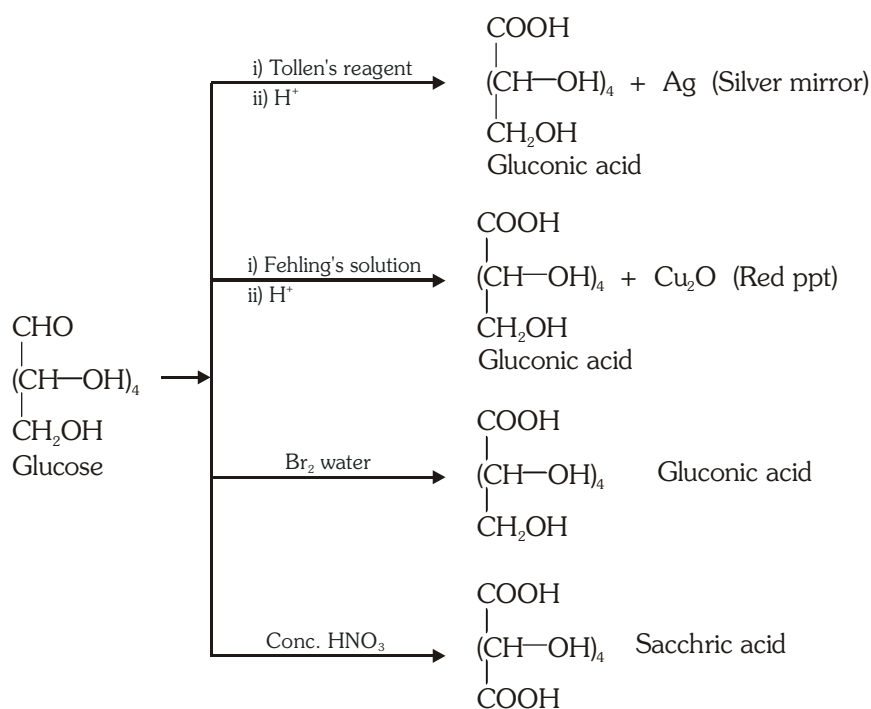


2. **From starch :** Commercially glucose is obtained by hydrolysis of starch by boiling it with dilute H₂SO₄ at 393 K under pressure.

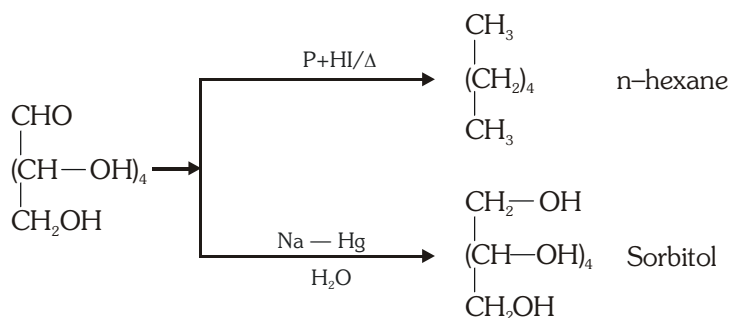


Chemical reactions of Glucose :

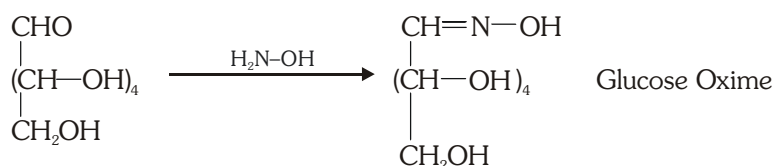
1. **Oxidation :**



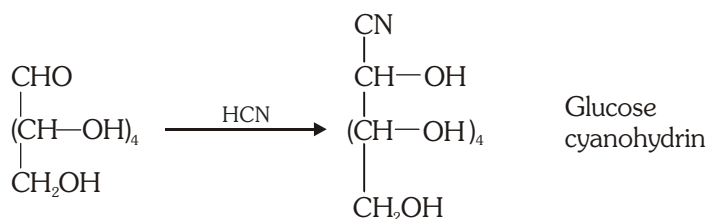
2. Reduction :



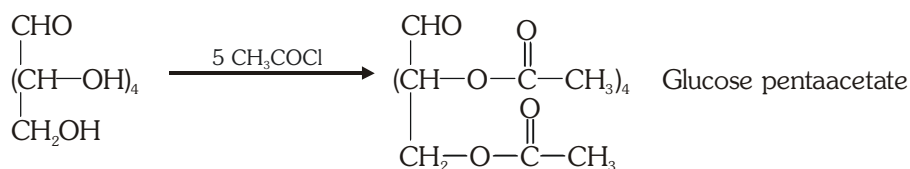
3. Reaction with hydroxyl amine :



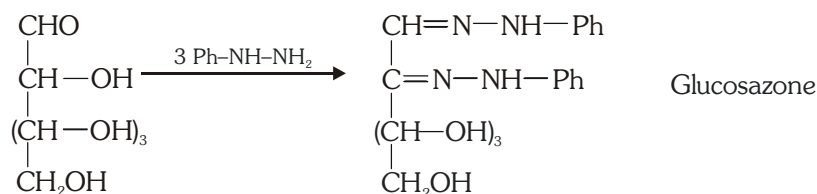
4. Reaction with hydrogen cyanide :



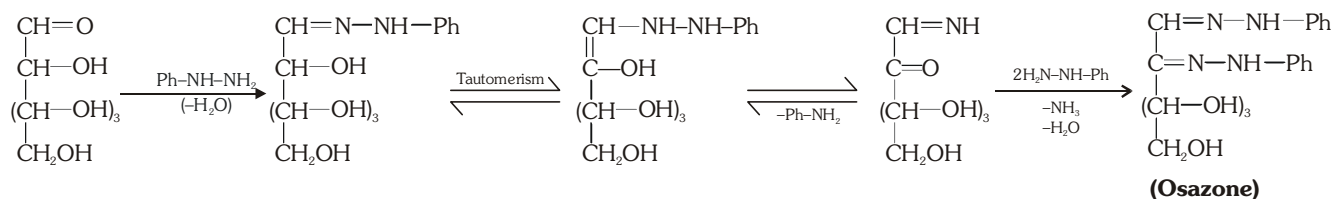
5. Acetylation :



6. Reaction with phenyl hydrazine :

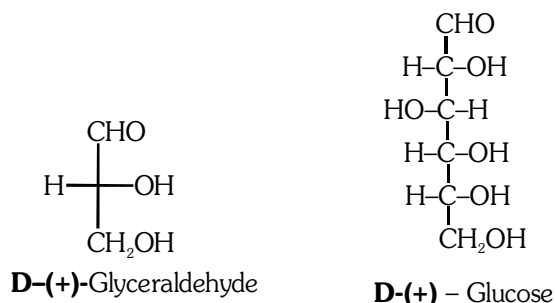


Mechanism :



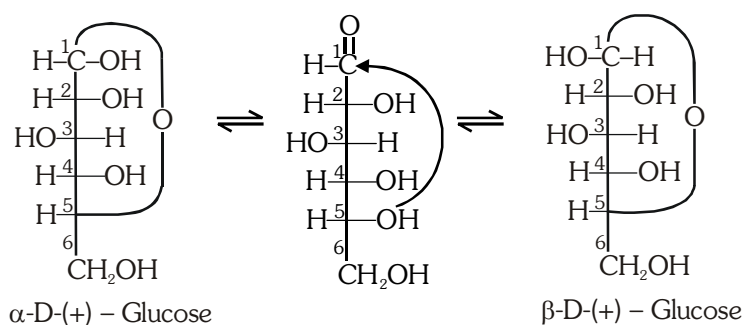
Configuration in monosaccharides :

For assigning the configuration of monosaccharides, it is the lowest asymmetric carbon atom (as shown below) which is compared. As in (+) glucose, —OH on the lowest asymmetric carbon is on the right side which is comparable to (+) glyceraldehyde, so it is assigned D-configuration.

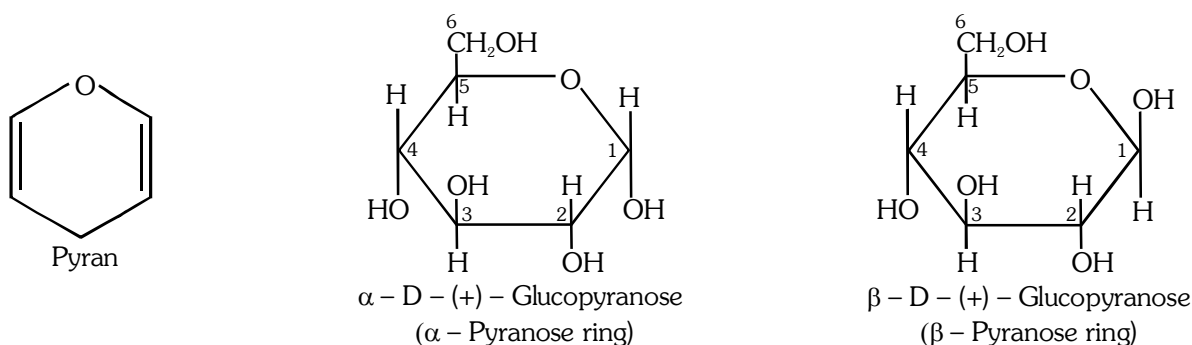


Cyclic structure of Glucose :-

It was found that glucose forms a six-membered ring in which —OH at C-5 is involved in ring formation. This explains the absence of —CHO group and also existence of glucose in two forms as shown below. These two cyclic forms exist in equilibrium with open chain structure.



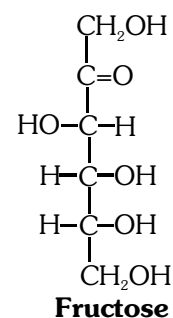
The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C₁, called anomeric carbon (the aldehyde carbon before cyclisation). Such isomers, i.e., α -form and β -form, are called **anomers**. The six membered cyclic structure of glucose is called **pyranose structure** (α - or β -), in analogy with pyran. Pyran is a cyclic organic compound with one oxygen atom and five carbon atoms in the ring. The cyclic structure of glucose is more correctly represented by **Haworth structure** as given below.



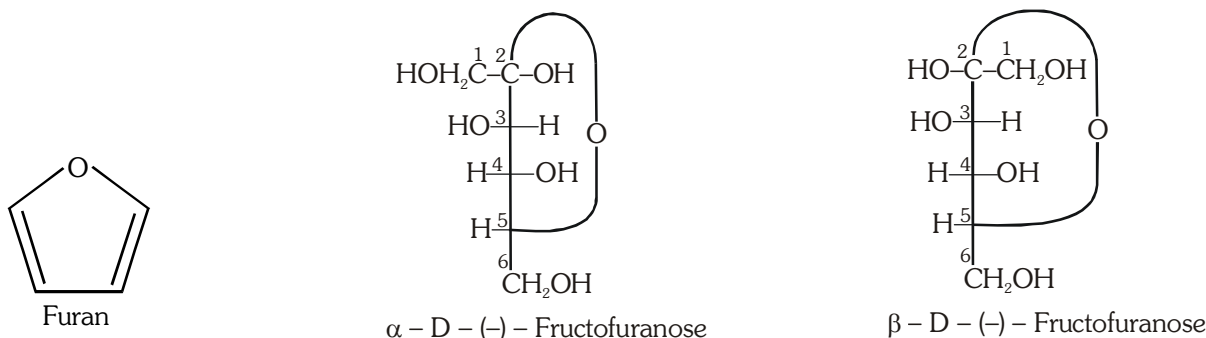
4.1.3 FRUCTOSE (KETOHEXOSE)

Structure of Fructose :

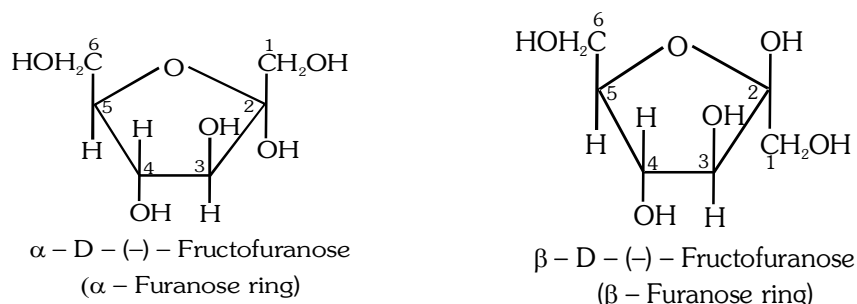
Fructose also has the **molecular formula $C_6H_{12}O_6$** and on the basis of its reactions it was found to contain **a ketonic functional group at carbon number 2** and six carbons in straight chain as in the case of glucose. It belongs to **D-series and is a laevorotatory compound**. It is appropriately written as **D-(-)-fructose**. Its open chain structure is as shown.



It also exists in two cyclic forms which are obtained by the addition of $-\text{OH}$ at C5 to the $(>\text{C}=\text{O})$ group. The ring, thus formed is a five membered ring and is named as **furanose** with analogy to the compound furan. Furan is a five membered cyclic compound with one oxygen and four carbon atoms.



The cyclic structures of two anomers of fructose are represented by Haworth structures as given.



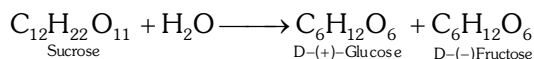
COMPARISON OF GLUCOSE AND FRUCTOSE			
S. No.	Property	Glucose	Fructose
1.	Molecular formula	$C_6H_{12}O_6$	$C_6H_{12}O_6$
2.	Nature	Polyhydroxy aldehyde	Polyhydroxy ketone
3.	Melting point	146°C	102°C
4.	Optical nature	Dextro rotatory	Leavo rotatory
5.	Tollen's reagent	Silver mirror	Silve mirror
6.	Fehling's solution	Red ppt	Red ppt
7.	Molisch test	Violet colour	Violet colour
8.	Phenyl hydrazine	Forms osazone	Forms osazone
9.	Oxidation by conc. HNO_3	Saccharic acid	Mixture of glycollic acid, Tartaric acid and Trihydroxy Gluteric acid



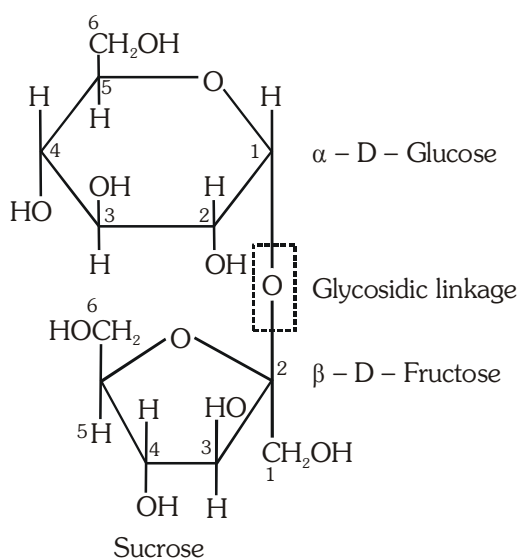
4.1.4 DISACCHARIDES

The two monosaccharides are joined together by an oxide linkage formed by the loss of a water molecule. Such a linkage between two monosaccharide units through oxygen atom is called **glycosidic linkage**.

- (i) **Sucrose** : One of the common disaccharides is **sucrose** which on hydrolysis gives equimolar mixture of D-(+)-glucose and D-(-) fructose.

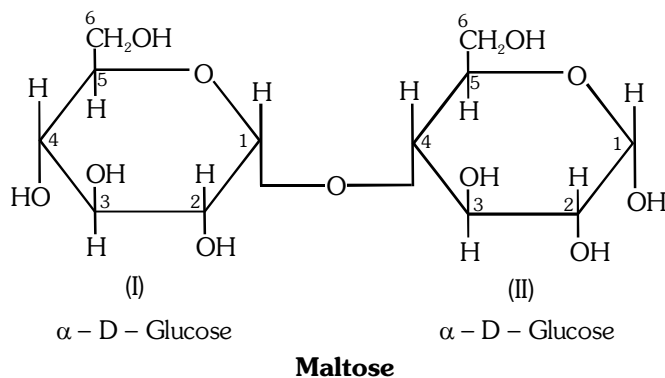


These two monosaccharides are held together by a glycosidic linkage between C₁ of α-glucose and C₂ of β-fructose. Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, sucrose is a **non reducing sugar**.

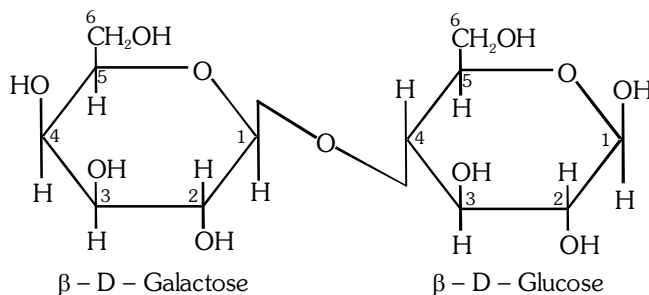


Hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (-) and the product is named as invert sugar.

- (ii) **Maltose**: Another disaccharide, maltose is composed of two α-D-glucose units in which C₁ of one glucose (I) is linked to C₄ of another glucose unit (II). The free aldehyde group can be produced at C₁ of second glucose in solution and it shows reducing properties so it is a **reducing sugar**.



- (iii) **Lactose** : It is more commonly known as milk sugar since this disaccharide is found in milk. It is composed of β -D-galactose and β -D-glucose. The linkage is between C_1 of galactose and C_4 of glucose. Hence it is also a **reducing sugar**.



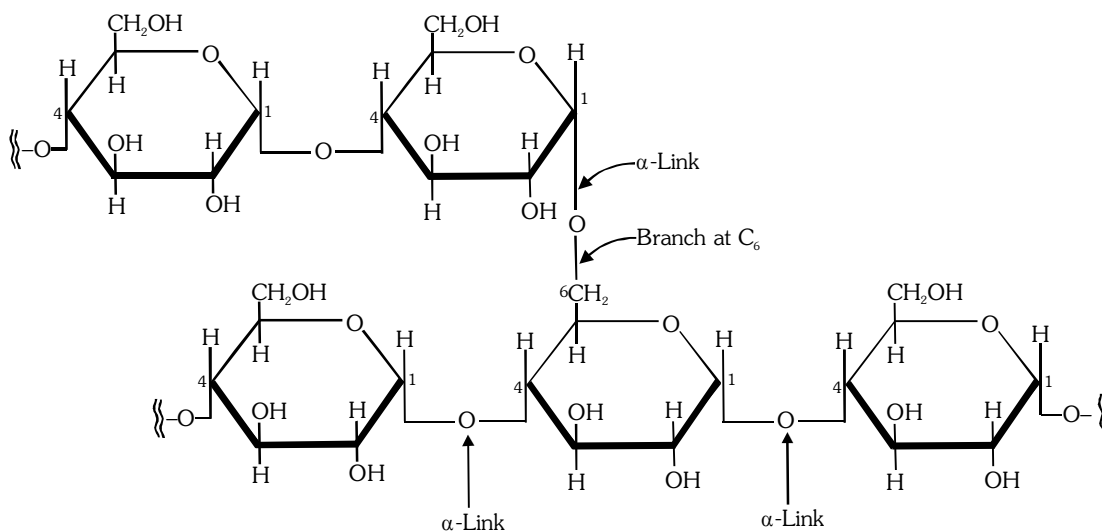
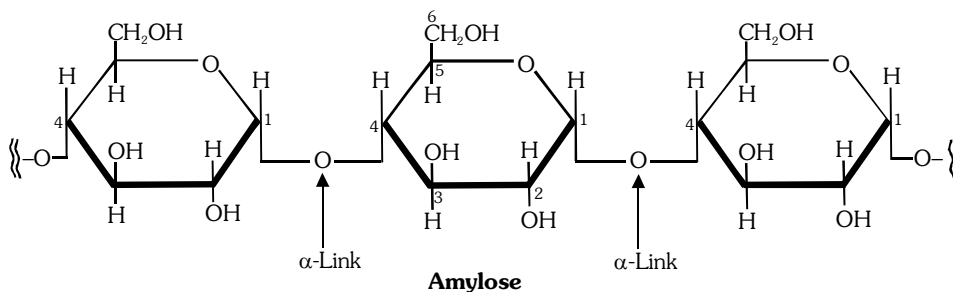
Lactose

4.1.5 POLYSACCHARIDES

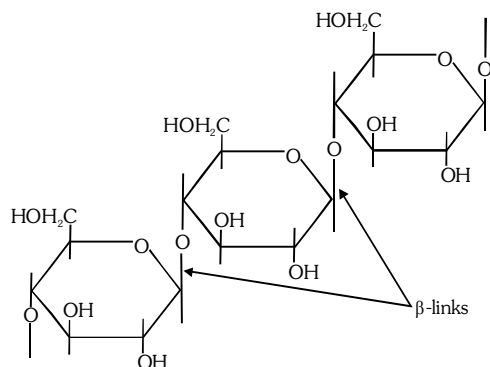
Polysaccharides contain a large number of monosaccharide units joined together by glycosidic linkages. They mainly act as the food storage or structural materials.

- (i) **Starch**: Starch is the main storage polysaccharide of plants. It is the most important dietary source for human beings. High content of starch is found in cereals, roots, tubers and some vegetables. It is a **polymer of α -glucose** and consists of two components—

Amylose and **Amylopectin**. Amylose is hot water soluble component which constitutes about 15-20% of starch. Chemically amylose is a long unbranched chain with 200-1000 α -D-(+)-glucose units held by C_1 - C_4 glycosidic linkage. Amylopectin is insoluble in hot water and constitutes about 80-85% of starch. It is a branched chain polymer of α -D-glucose units in which chain is formed by C_1 - C_4 glycosidic linkage whereas branching occurs by C_1 - C_6 glycosidic linkage.



- (ii) **Cellulose** : Cellulose occurs exclusively in plants and it is the most abundant organic substance in plant kingdom. It is a predominant constituent of cell wall of plant cells. Cellulose is a straight chain polysaccharide composed only of **β -D-glucose** units which are joined by glycosidic linkage between C_1 of one glucose unit and C_4 of the next glucose unit.

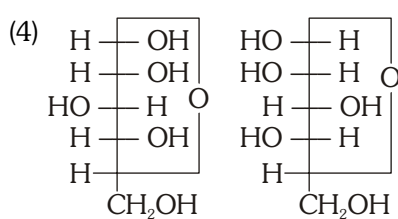
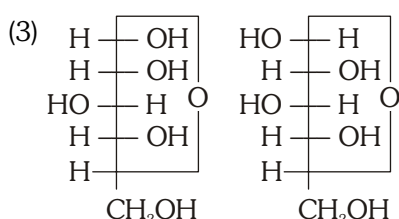
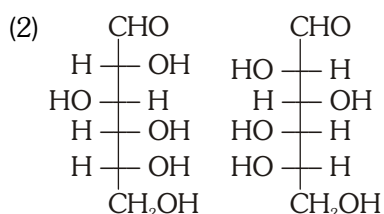
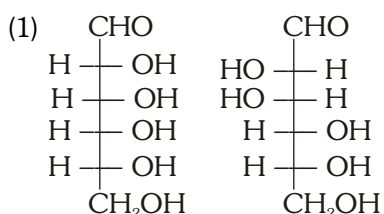


Cellulose

- (iii) **Glycogen** : The carbohydrates are stored in animal body as glycogen. It is also known as **animal starch** because its structure is similar to amylopectin and is rather more highly branched. It is present in liver, muscles and brain. When the body needs glucose, enzymes break the glycogen down to glucose. Glycogen is also found in yeast and fungi.

BEGINNER'S BOX-1

- Glucose can be tested by following –
 - (1) Tollen's reagent
 - (2) Fehling's solution
 - (3) Both of these
 - (4) None of these
- Glucose on oxidation with nitric acid as well as gluconic acid both gives –
 - (1) Saccharic acid
 - (2) n-Hexane
 - (3) Fructose
 - (4) Glucosazone
- The spontaneous change in specific rotation of an optically active compound is called –
 - (1) Mutarotation
 - (2) Rearrangements
 - (3) Inversion
 - (4) Retention
- Hydrolysis of sucrose brings about a change in sign of rotation from dextro(+) to Laevo(–) and such a sign change is known as –
 - (1) Racemization
 - (2) Inversion
 - (3) Mutarotation
 - (4) None of these
- Which of the following pairs represents anomer:-



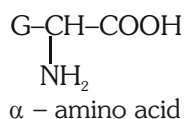
4.2 PROTEINS

The word protein is derived from Greek word, “**proteios**” which means primary or of prime importance.

All proteins are polymers of **α -L-amino acids**.

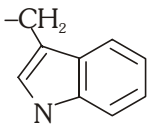
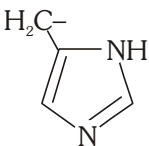
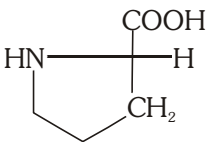
Amino acids : Amino acids contain amino ($-\text{NH}_2$) and carboxyl ($-\text{COOH}$) functional groups.

Depending upon the relative position of amino group with respect to carboxyl group, the amino acids can be classified as α , β , γ , δ and so on. Only α -amino acids are obtained on hydrolysis of proteins. They may contain other functional groups also.



	Name of the amino acids	Characteristic feature of side chain, G	Three letter symbol	One letter code
1.	Glycine	H	Gly	G
2.	Alanine	$-\text{CH}_3$	Ala	A
3.	Valine*	$(\text{H}_3\text{C})_2 \text{CH}-$	Val	V
4.	Leucine*	$(\text{H}_3\text{C})_2 \text{CH}-\text{CH}_2-$	Leu	L
5.	Isoleucine*	$\begin{array}{c} \text{H}_3\text{C}-\text{CH}_2-\text{CH}- \\ \\ \text{CH}_3 \end{array}$	Ile	I
6.	Arginine*	$\begin{array}{c} \text{HN}=\text{C}-\text{NH}-(\text{CH}_2)_3- \\ \\ \text{NH}_2 \end{array}$	Arg	R
7.	Lysine*	$\text{H}_2\text{N}-(\text{CH}_2)_4-$	Lys	K
8.	Glutamic acid	$\text{HOOC}-\text{CH}_2-\text{CH}_2-$	Glu	E
9.	Aspartic acid	$\text{HOOC}-\text{CH}_2-$	Asp	D
10.	Glutamine	$\begin{array}{c} \text{O} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CH}_2-\text{CH}_2- \end{array}$	Gln	Q
11.	Asparagine	$\begin{array}{c} \text{O} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CH}_2- \end{array}$	Asn	N
12.	Threonine*	$\text{H}_3\text{C}-\text{CHOH}-$	Thr	T
13.	Serine	$\text{HO}-\text{CH}_2-$	Ser	S
14.	Cysteine	$\text{HS}-\text{CH}_2-$	Cys	C



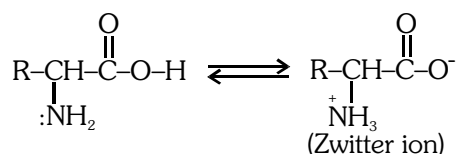
15.	Methionine*	$\text{H}_3\text{C}-\text{S}-\text{CH}_2-\text{CH}_2-$	Met	M
16.	Phenylalanine*	$\text{C}_6\text{H}_5-\text{CH}_2-$	Phe	F
17.	Tyrosine	(p) $\text{HO}-\text{C}_6\text{H}_4-\text{CH}_2-$	Tyr	Y
18.	Tryptophan*		Trp	W
19.	Histidine*		His	H
20.	Proline ^(a)		Pro	P

* essential amino acid, a = entire structure

4.2.1 Classification of Amino Acids : Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecule.

- The amino acids, which can be synthesised in the body, are known as **non-essential amino acids**. On the other hand, those which cannot be synthesised in the body and must be obtained through diet, are known as **essential amino acids**.

Amino acids are usually colourless, crystalline solids. These are water-soluble, high melting solids and behave like salts rather than simple amines or carboxylic acids. This behaviour is due to the presence of both acidic (carboxyl group) and basic (amino group) groups in the same molecule.



In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as **zwitter ion**. This is neutral but contains both positive and negative charges.

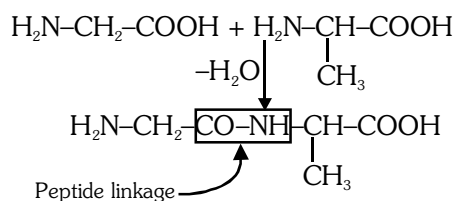
In zwitter ionic form, amino acids show **amphoteric** behaviour as they react both with acids and bases.

Except glycine, all other naturally occurring α-amino acids are optically active, since the α-carbon atom is asymmetric. These exist both in 'D' and 'L' forms. Most naturally occurring amino acids have L-configuration. **L-Aminoacids** are represented by writing the $-\text{NH}_2$ group on left hand side.

4.2.2 Structure of Proteins :

Proteins are the polymers of α-amino acids and they are connected to each other by **peptide bond** or **peptide linkage**. Chemically, peptide linkage is an amide formed between $-\text{COOH}$ group and $-\text{NH}_2$ group.





Glycylalanine [Gly-Ala]

The reaction between two molecules of similar or different amino acids, proceeds through the combination of the amino group of one molecule with the carboxyl group of the other. This results in the elimination of a water molecule and formation of a **peptide bond** $-\text{CO}-\text{NH}-$.

Proteins can be classified into two types on the basis of their molecular shape.

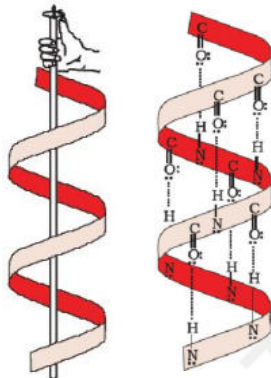
(a) Fibrous proteins

When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre-like structure is formed. Such proteins are generally insoluble in water. Some common examples are keratin (present in hair, wool, silk) and myosin (present in muscles), etc.

(b) Globular proteins

This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water. Insulin and albumins are the common examples of globular proteins.

Structure and shape of proteins can be studied at four different levels, i.e., primary, secondary, tertiary and quaternary, each level being more complex than the previous one.



- (i) **Primary structure of proteins:** Proteins may have one or more polypeptide chains. Each polypeptide in a protein has amino acids linked with each other in a specific sequence and it is this sequence of amino acids that is said to be the primary structure of that protein. Any change in this primary structure (i.e., the sequence of amino acids) creates a different protein.
- (ii) **Secondary structure of proteins:** The secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structures viz. α -helix and β -pleated sheet structure. These structures arise due to the regular folding of the backbone

of the polypeptide chain due to hydrogen bonding between $-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-$ and $-\text{NH}-$ groups of the peptide bond.

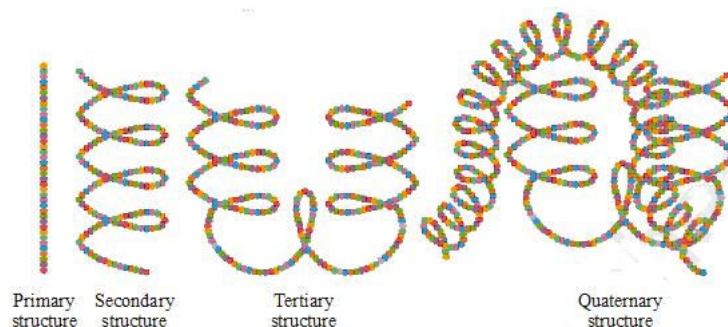
α -Helix is one of the most common ways in which a polypeptide chain forms all possible hydrogen bonds by twisting into a right handed screw (helix) with the $-\text{NH}$ group of each amino acid residue hydrogen bonded to the >C=O of an adjacent turn of the helix.



In β -structure all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by intermolecular hydrogen bonds. The structure resembles the pleated folds of drapery and therefore is known as β -pleated sheet.

- (iii) **Tertiary structure of proteins:** The tertiary structure of proteins represents overall folding of the polypeptide chains i.e., further folding of the secondary structure. It gives rise to two major molecular shapes viz. fibrous and globular. The main forces which stabilise the 2° and 3° structures of proteins are hydrogen bonds, disulphide linkages, van der Waals and electrostatic forces of attraction.
- (iv) **Quaternary structure of proteins :** Some of the proteins are composed of two or more polypeptide chains referred to as sub-units. The spatial arrangement of these subunits with respect to each other is known as quaternary structure.

A diagrammatic representation of all these four structures is given in figure.



4.2.3 Denaturation of Proteins :

Physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called **denaturation** of protein. The coagulation of egg white on boiling is a common example of denaturation. Another example is curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.

During denaturation secondary and tertiary structures are destroyed but primary structure remains unchanged.

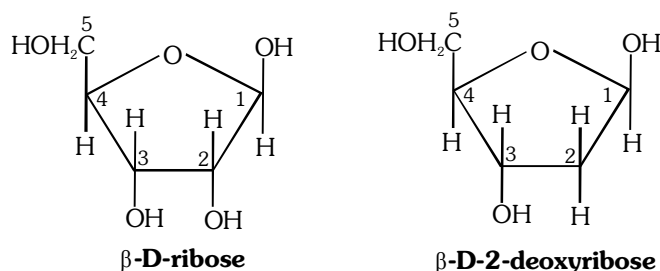
4.3 NUCLEIC ACIDS

Introduction :

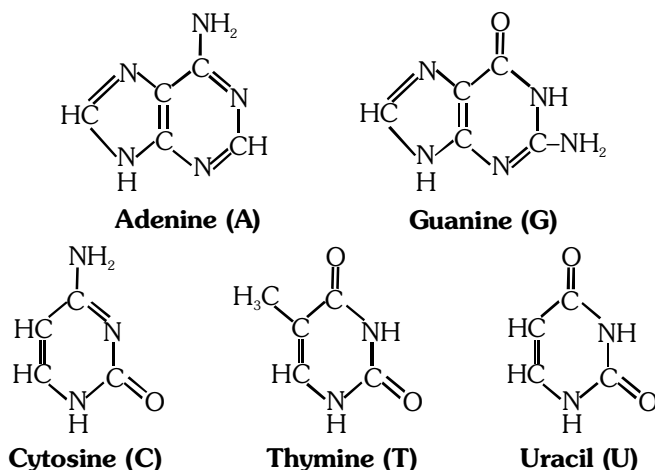
It has been observed that nucleus of a living cell is responsible for the transmission of inherent characters, also called **heredity**. The particles in nucleus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called **nucleic acids**. These are mainly of two types, the **deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)**. Since nucleic acids are long chain polymers of **nucleotides**, so they are also called polynucleotides.

4.3.1 Chemical composition of Nucleic Acids :

Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds (called bases). In DNA molecules, the sugar moiety is **β -D-2-deoxyribose** whereas in RNA molecule, **it is β -D-ribose**.

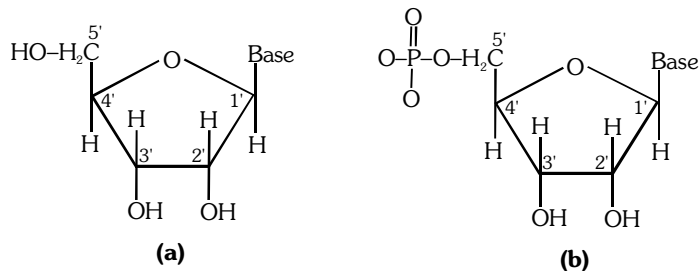


DNA contains four bases viz. **adenine** (A), **guanine** (G), **cytosine** (C) and **thymine** (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is uracil (U).



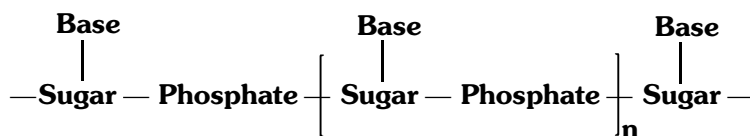
4.3.2 Structure of Nucleic Acids :-

A unit formed by the attachment of a base to 1' position of sugar is known as **nucleoside**. In nucleosides, the sugar carbons are numbered as 1', 2', 3', etc. in order to distinguish these from the bases. When nucleoside is linked to phosphoric acid at 5'-position of sugar moiety, we get a nucleotide.

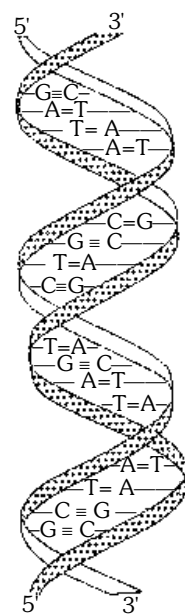


Structure of (a) a nucleoside and (b) a nucleotide

Nucleotides are joined together by **phosphodiester linkage** between 5' and 3' carbon atoms of the pentose sugar. A simplified version of nucleic acid chain is as shown below. Fig.



Information regarding the sequence of nucleotides in the chain of a nucleic acid is called its primary structure. Nucleic acids have a secondary structure also. James Watson and Francis Crick gave a double strand helix structure for DNA (Fig.). Two nucleic acid chains are wound about each other and held together by hydrogen bonds between pairs of bases. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases. Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine. In secondary structure of RNA, helices are present which are only single stranded. Sometimes they fold back on themselves to form a double helix structure. RNA molecules are of three types and they perform different functions. They are named as **messenger RNA (m-RNA)**, **ribosomal RNA (r-RNA)** and **transfer RNA (t-RNA)**.



Double strand helix structure for DNA

BEGINNER'S BOX-2

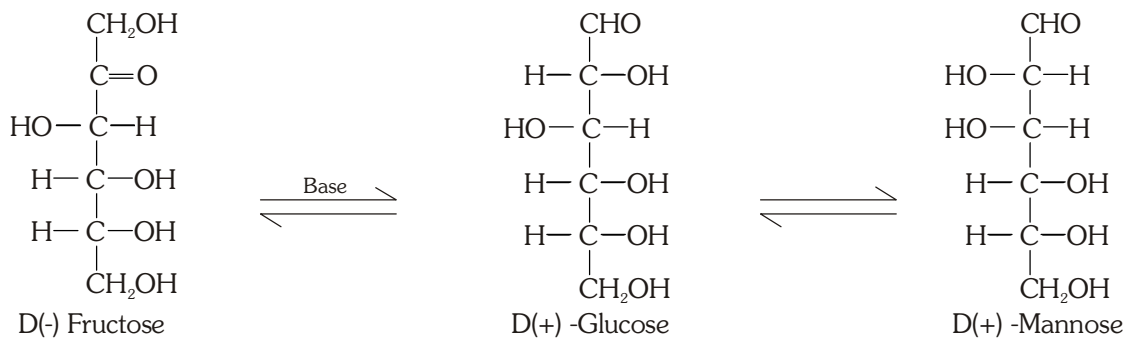
1. Zwitter ion is –
 (1) neutral ion (2) positive charge ion (3) negative ion (4) None of these
2. In β -sheet of proteins, conformers are held together by (Secondary structure of protein) –
 (1) Intermolecular H-bond (2) Intramolecular H-bond
 (3) Conformers not held together (4) None of these
3. DNA contains following purines bases –
 (a) Adenine (b) Guanine (c) Thymine (d) Cytosine
 (1) a, c (2) a, b (3) a, c, d (4) a, b, c, d
4. Which of the following statement is/are true –
 (1) DNA has deoxyribose while RNA has ribose sugar (2) DNA contains thymine while RNA has uracil
 (3) Both of these (4) None of these
5. RNA on translation gives –
 (1) Protein (2) DNA (3) Both (4) None of these

GOLDEN KEY POINTS

TEST FOR BIOMOLECULES

(I) Lobry de Bruyn van Eikenstein rearrangement :

Glucose contains —CHO group and hence reduces fehling's solution. Fructose, on the other hand, contains >C=O group but still reduces Fehling's solution. This is due to the reason that under basic conditions of the reagent, fructose undergoes a reversible isomerization and is converted into a mixture of glucose and mannose - both of which contain —CHO group and hence reduce fehling's solution.



This conversion of fructose into a mixture of glucose and mannose under basic conditions is called Lobry de Bruyn van Eikenstein rearrangement.

(II) Test of carbohydrates : Molish test is used for detection of all types of carbohydrates, i.e., monosaccharides, disaccharides and polysaccharides.

Molisch reagent (1% alcoholic solution of α - naphthol) is added to the aqueous solution of a carbohydrate followed by conc. H_2SO_4 along the sides of the test tube. A violet ring is formed at the junction of the two layers.

(III) Tests of Proteins:

Biuret test: An alkaline solution of a protein when treated with a few drops of 1% CuSO_4 solution, produces a violet colouration. The colour is due to the formation of a coordination complex of Cu^{+2} with >C=O and —NH— groups of the peptide linkages.



4.4 VITAMINS

	Vitamin	Sources	Deficiency diseases
(i)	Vitamin-A (Retinol or eye vitamin)	Milk, cod liver oil, butter, carrots, green leaves, tomatoes, eggs, etc.	Night blindness, xerophthalmia (i.e. hardening of cornea of eye) and xerosis.
(ii)	Vitamin-B ₁ Thiamine or Aneurin	Pulses, nuts, green vegetables, Polished rice. yeast and egg yolk.	Beriberi (a disease of nervous system) and loss appetite.
(iii)	Vitamin - B ₂ or Riboflavin or Lactoflavin	Milk, meat, green vegetables and yeast.	Inflammation of tongue or dark red tongue (glossitis), and cheilosis (cracking or fissuring the lips and corners of the mouth)
(iv)	Vitamin-B ₆ or Pyridoxine or Adermine	Rice, bran, yeast, meat, fish, egg, yolk, maize, spinach and lettuce.	Specific dermatitis called acrodynia, pellagra (shrivelled skin) anaemia and convulsions.
(v)	Vitamin-B ₁₂ or Cyanocobblamin	Milk, liver, kidney and eggs.	Inflammation of tongue, mouth etc. and pernicious anaemia.
(vi)	Vitamin-C or L-Ascorbic acid	Citrous fruits, amla, (oranges, lemons), sprouted pulses, germinated grains and leafy vegetables.	Scurvy and brittleness of bones, swelling and bleeding of gums and loosening of teeth.
(vii)	Vitamin D or Ergocalciferol (or antirachitic Vitamin of sunshine vitamin)	Fish liver oil, cod liver oil, milk and eggs.	Rickets (softening and bending of bones) in children, controls Ca and P metabolism.
(viii)	Vitamin-E or Tocopherols (α , β and γ) or Antisterility factor	Eggs, milk, fish, wheat germ, oil, cotton seed oil etc.	Sterility (loss of sexual power and reproduction)
(ix)	Vitamin-H (Biotin)	Yeast, liver, Kidney and milk.	Dermatitis, loss of hair and paralysis.
(x)	Vitamin-K or Phylloquinones or Antihaemorrhagic vitamin	Cabbage, alfalfa, spinach and carrot tops.	Haemorrhage and lengthens time of blood clotting.
(xi)	Coenzyme Q ₁₀	Chloroplasts of green plants and mitochondria of animals	Low order of immunity of body against many diseases



4.5 HORMONES

Hormones are biomolecules which are produced in the ductless (endocrine) glands and are carried to different parts of the body by the blood stream where they control various metabolic processes. These are required in minute quantities and unlike fats and carbohydrates these are not stored in the body but are continuously produced.

Some important hormones along with the sources and functions are summarised below :

NAME	ORGAN OF SECRETION	FUNCTIONS
I. Steroidal hormones		
A. Sex hormones		
(a) Androgens (Testosterone)	Testes	Control the development and normal functioning of Androsterone and male sex organs.
(b) Estrogens (Estrone, Estradiol, Estriol)	Ovary	Control the development and normal functioning of female sex organs.
(c) Gestogens (Progesterone)	Corpus luteum	Control the development and maintenance of pregnancy.
B. Adrenal cortex hormones or corticoids (Cortisone, Corticosterone, Aldosterone etc.)	Adrenal cortex	Regulate the metabolism of fats, proteins and carbohydrates; control the balance of water and minerals in the body.
II. Peptide hormones		
(i) Oxytocin	Posterior pituitary gland	Controls the contraction of the uterus after child birth and releases milk from the mammary glands.
(ii) Vasopressin	Posterior pituitary gland	Controls the reabsorption of water in the kidney.
(iii) Angiotensin II	Blood plasma of persons with high blood pressure.	Potent vasoconstrictor i.e. contracts the blood vessels.
(iv) Insulin	Pancreas	Controls the metabolism of glucose, maintains glucose level in the blood.
III. Amine hormones		
(i) Adrenaline or Epinephrine	Adrenal medulla	It is an amine compound and was the first hormone to be isolated. Prepares animals and humans for emergency in many ways by raising the pulse rate, blood pressure etc. stimulates the breakdown of liver glycogen into blood glucose and fats into fatty acids during emergency. These properties make adrenaline as one of the most valuable drugs used in medicine.
(ii) Thyroxine	Thyroid gland	Controls metabolism of carbohydrates, lipids and proteins.



GOLDEN KEY POINTS

- Monosaccharides which differ in configuration at first chiral carbon are called anomers. thus, α -D-glucose and β -D-glucose are anomers and so are α -D-fructose and β -D-fructose.
- The C_1 carbon atom in aldoses and C_2 carbon atom in ketoses around which the configuration of anomers differs is called anomeric or the glycosidic carbon.
- Monosaccharides which differ in configuration at any one carbon atom are called epimers. Thus, glucose and mannose which differ in Configuration at C_2 are called C_2 -epimers while glucose and galactose which differ in configuration at C_4 are called C_4 epimers.
- All monosaccharides (aldoses and ketoses) and disaccharides except sucrose reduce fehling's solution, Benedict's solution and Tollen's reagent and hence are called reducing sugars. Others (sucrose, starch, cellulose) which do not reduce these reagents are called non-reducing carbohydrates.
- The spontaneous change of specific rotation with time to an equilibrium value is called mutarotation. All reducing carbohydrates i.e. monosaccharides (glucose, fructose, mannose etc.) and disaccharides (maltose, lactose etc.) undergo mutarotation in aqueous solutions.
- Since glucose (grape sugar) is dextrorotatory, it is also called dextrose. Similarly, fructose being laevorotatory is also called laevulose.
- α -Amino acids are the building blocks of proteins or proteins are the condensation polymers of α -amino acids.
- All the α -amino acids forming proteins have L- configuration while all the naturally occurring carbohydrates have D-configuration.
- DNA undergoes replication and controls transmission of hereditary effects from one generation to the other while RNA controls synthesis of proteins.
- Vitamin D_2 is also called sunshine vitamin since it is obtained by sunlight irradiation of ergosterol present in oils and fats.
- The α -helix structure of proteins is also called 3.6_{13} helix since each turn of the helix has approx. 3.6 amino acids and a 13-member ring is formed by H-bonding.
- The deficiency of protein causes the disease called Kwashiorkor.
- Thiamine is vitamin B_1 while thymine is a pyrimidine base which occurs in DNA.

COMPETITION WINDOW

- All monosaccharides and reducing disaccharides (maltose, lactose etc.) react with three molecules of $C_6H_5NHNH_2$ to form crystalline osazones which are used for their identification and characterization. Further all monosaccharides which differ in configuration at C_1 and C_2 give the same osazone, i.e. glucose, fructose and Mannose.
- Both starch and cellulose are condensation polymers of glucose. Starch is a polymer of α -glucose, whereas cellulose is polymer of β -glucose.
- At isoelectric point, the amino acids primarily exist as the neutral dipolar or zwitterion and hence have the minimum solubility. All amino acid have their own isoelectric point.
- In amino acids. $-COO^\ominus$ group acts as the base while $-NH_3^+$ acts as the acid.



- The biological activity of proteins is due to their secondary and tertiary structures.
- Adenosine (ribose + adenine) is a nucleoside while adenosine monophosphate (AMP), adenosine diphosphate and adenosine triphosphate (ATP) are all nucleotides.
- ATP is called energy currency of the cells. It is a nucleotide containing adenine as the purine base, ribose as the sugar and three inter-linked phosphate groups.
- Energy is stored in living cells in form of ATP.
- Haemoglobin is a globular protein and the red colour of haemoglobin is due to the iron-protoporphyrin complex called the heme.
- Water soluble vitamins are B-complex and C.
- Water insoluble vitamins are A,D,E, and K.
- Vitamins which act as antioxidants are C,D and E.
- Calorific value of various food stuffs follows the Sequence : Fats > Carbohydrates > proteins.

ANSWER KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5					
	Ans.	3	1	1	2	3					
BEGINNER'S BOX-2	Que.	1	2	3	4	5					
	Ans.	1	1	2	3	1					



POLYMER

Polymer is defined as a high molecular weight compound formed by the combination of a large number of one or more types of small molecules (Monomers)

CLASSIFICATION OF POLYMERS :

5.1 BASED ON SOURCE

- (a) Natural polymers (b) Semi-Synthetic polymers (c) Synthetic polymers

(a) **Natural polymers:** These are of natural origin and these are found in plants and animals.

Natural polymers are also called as biopolymers.

Example Proteins (Polymers of amino acids), Polysaccharides (Polymers of mono saccharides), rubber (Polymers of isoprene) silk, wool, starch, cellulose, enzymes, haemoglobin etc.

(b) **Semi Synthetic polymers :**

Examples Nitro cellulose, cellulose acetate, cellulose xanthate, etc.

(c) **Synthetic Polymers :** These are artificial polymers. For example Polythene, nylon, PVC, bakelite, dacron.

5.2 BASED ON STRUCTURE OF POLYMERS.

(1) **Linear polymers**

→ These polymers consist of long and straight chains.

→ Ex. Polyvinyl chloride, high density polythene.

(2) **Branched chain polymers**

→ These polymers contain linear chain having some branches.

Ex. – Low density polythene.

(3) **Cross linked polymers**

→ Contain strong covalent bond between various linear polymer chains.

Ex. – Bakelite, Melamine

5.3 BASED ON MODE OF POLYMERISATION :

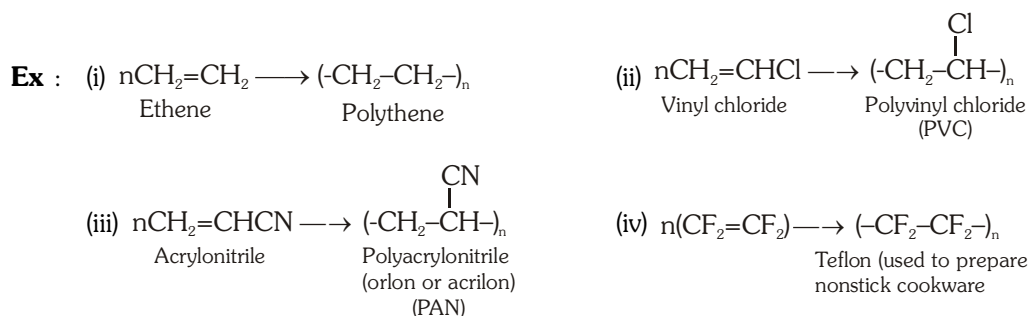
(1) **Addition polymer : (Chain growth polymerisation)**

→ Formed by the repeated addition of monomer molecules

→ Without elimination of any thing.

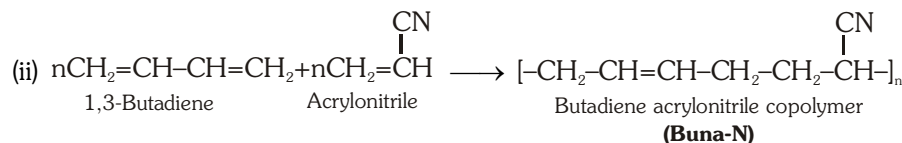
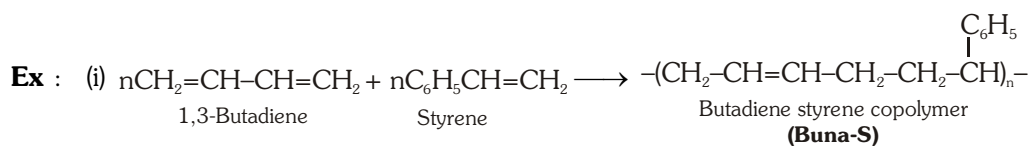
Types :

(a) **Homopolymers :** Addition polymers formed by the polymerisation of a single monomeric species.



(b) Copolymers :

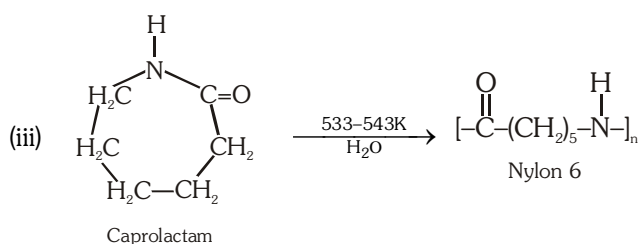
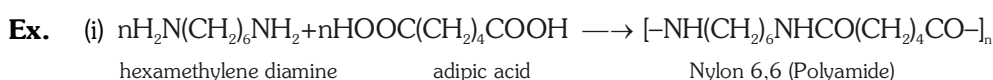
Addition polymers formed by the polymerisation of two different monomers.



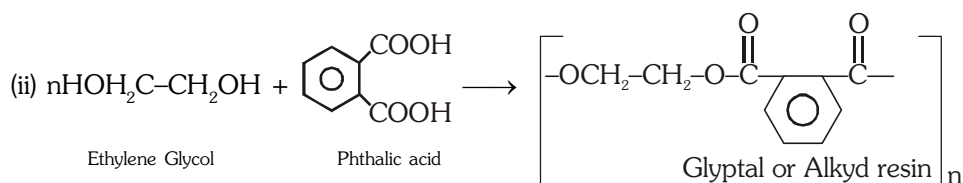
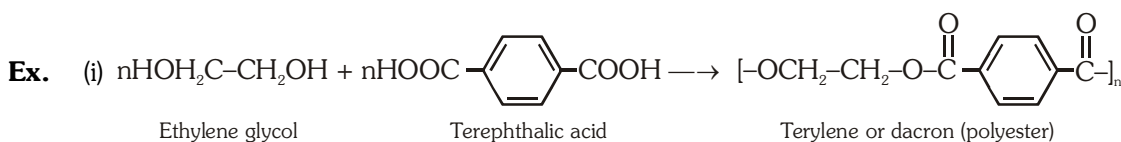
(2) Condensation polymers : (Step growth polymerisation)

In these polymerisation reaction, the elimination of small molecules such as water, alcohol, hydrogen chloride take place.

(a) Polyamide :

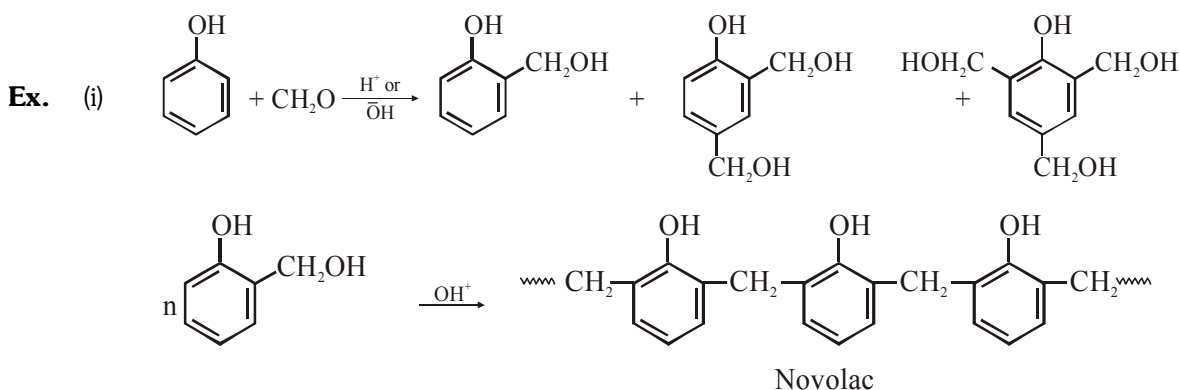


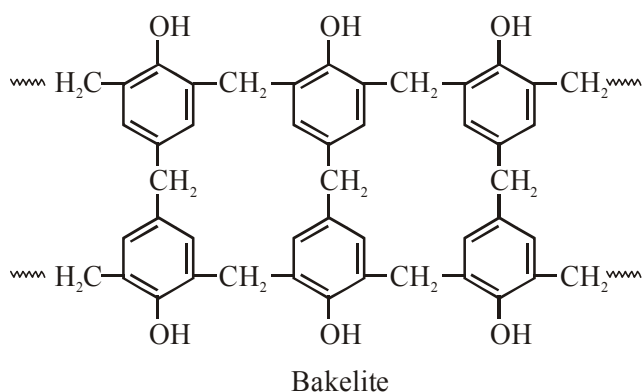
(b) Polyester :



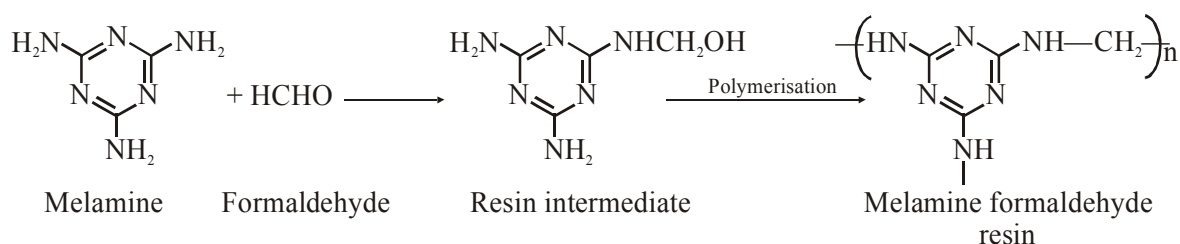
(c) Formaldehyde polymer (Bakelite and related polymers) –

(i) Bakelite :





(ii) Melamine - formaldehyde polymer -



5.4 BASED ON MOLECULAR FORCES :

(1) Elastomers :

- The polymer chains are held together by the weakest intermolecular forces.
- These weak binding forces permit the polymer to be stretched.

Ex. : Buna-S, Buna-N, neoprene

(2) Fibres :

- Fibres are the thread forming solids which possess high tensile strength and strong intermolecular forces.

Ex. : Nylon 66, polyesters (terylene)

(3) Thermoplastic :

- These are the linear or slightly branched long chain molecules capable of repeatedly softening on heating and hardening on cooling.

Ex. : Polythene, Polystyrene ; polyvinyls.

(4) Thermosetting plastic :

- These polymers are cross linked or heavily branched molecules.
- These cannot be reused

Ex. : Bakelite, urea - formaldehyde.

Note: Correct order for Intermolecular forces in various classes of polymers.

Thermosetting > Fibres > Thermoplastic > Elastomers.

5.5 PREPARATION OF SOME IMPORTANT POLYMERS.

(1) Low density polythene :

- Formed by free radical addition in presence of peroxide.
- Chemically inert and poor conductor of electricity.
- Used in the insulation of electric wires and squeeze bottles, flexible pipes.

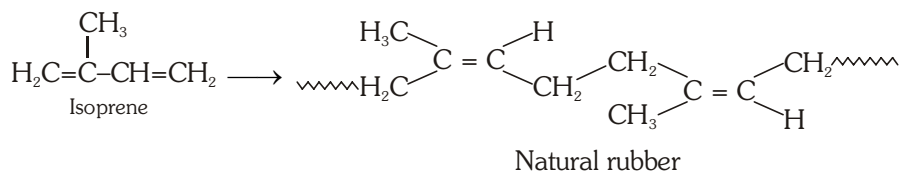


(2) High density polythene :

- Formed in presence of titanium tetrachloride (TiCl_4) + triethyl aluminium ($\text{C}_2\text{H}_5\text{Al}$) [Ziegler – Natta catalyst]
- It is chemically inert and more tougher and harder.
- It is used for manufacturing buckets, bottles.

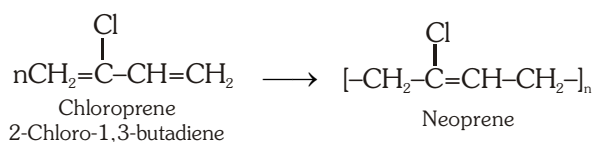
(3) Natural rubber :

- Linear polymer of cis-isoprene (2-methyl-1,3-butadiene) and is also called as **cis-1,4-polyisoprene**



- **Vulcanisation of rubber :** Natural rubber becomes soft at high temperature. To improve upon these physical properties, a process of vulcanisation is carried out. This process consists of heating a mixture of raw rubber with sulphur. On vulcanisation, sulphur forms cross links at the reactive sites of double bond.

(4) Synthetic rubber (Neoprene)



5.6 BIODEGRADABLE POLYMERS

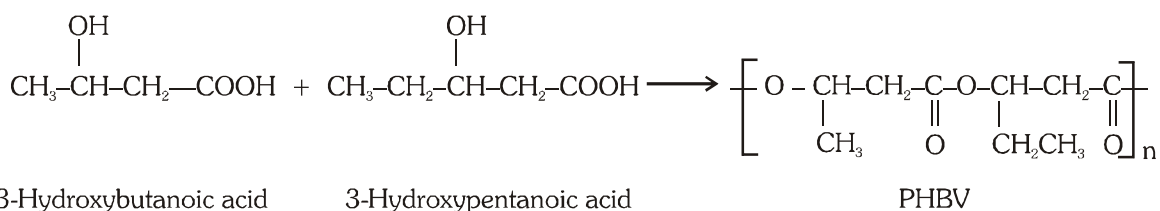
Introduction

A large number of polymers are quite resistant to the environmental degradation processes and are thus responsible for the accumulation of polymeric solid waste materials. These solid wastes cause acute environmental problems and remain undegraded for quite a long time. In view of the general awareness and concern for the problems created by the polymeric solid wastes, certain new biodegradable synthetic polymers have been designed and developed. These polymers contain functional groups similar to the functional groups present in biopolymers.

Examples :

(1) Poly (β -hydroxybutyrate- β -hydroxy valerate) (PHBV)

It is obtained by the copolymerisation of 3-hydroxybutanoic acid and 3-hydroxypentanoic acid. PHBV is used in speciality packaging, orthopaedic devices and in controlled release of drugs. PHBV undergoes bacterial degradation in the environment.



(2) Nylon 2-nylon 6

It is an alternating polyamide copolymer of glycine ($\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$) and amino caproic acid [$\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$].



BEGINNER'S BOX-1

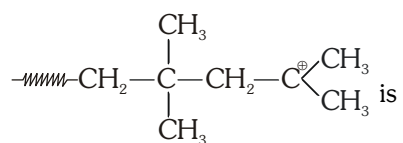
1. Which of the following is a biodegradable polymer

- | | |
|------------------------|---------------|
| (1) Cellulose | (2) Polythene |
| (3) Polyvinyl chloride | (4) Nylon-6 |

2. Which one of the following is a chain growth polymer

- | | |
|------------------|-----------------|
| (1) Nucleic acid | (2) Polystyrene |
| (3) Protein | (4) Starch |

3. The monomer of the polymer –



- | | |
|---|---|
| (1) $\text{CH}_3\text{CH}=\text{CHCH}_3$ | (2) $\text{CH}_3\text{CH}=\text{CH}_2$ |
| (3) $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_3)_2$ | (4) $\text{H}_2\text{C}=\text{C}\begin{matrix} \text{CH}_3 \\ \text{CH}_3 \end{matrix}$ |

4. Which of the following polymer is biodegradable

- | | |
|--|--|
| (1) $(\text{---CH}_2\text{---}\underset{\text{Cl}}{\text{C}}=\text{CH---CH}_2\text{---})_n$ | (2) $(\text{---CH}_2\text{---CH}=\text{CH---CH}_2\text{---CH}_2\text{---}\underset{\text{CH}_3}{\text{CH}}\text{---})_n$ |
| (3) $(\text{---O---}\underset{\text{CH}_3}{\text{CH}}\text{---CH}_2\text{---}\underset{\text{O}}{\text{C}}\text{---O---}\underset{\text{CH}_2\text{---CH}_3}{\text{CH}}\text{---CH}_2\text{---}\underset{\text{O}}{\text{C}}\text{---})_n$ | (4) $(\text{---}\underset{\text{H}}{\text{N}}\text{---}(\text{CH}_2)_6\text{---}\underset{\text{H}}{\text{N}}\text{---}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{---}(\text{CH}_2)_4\text{---}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{---})_n$ |

5. Which of the following is not correctly matched –

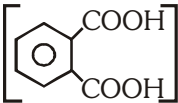
- | | |
|---|--|
| (1) Neoprene $\left[\text{---CH}_2\text{---}\underset{\text{Cl}}{\text{C}}=\text{CH---CH}_2\text{---} \right]_n$ | (2) Nylone-6,6 $\left[\text{---NH(CH}_2)_6\text{NHCO(CH}_2)_4\text{C(=O)---} \right]_n$ |
| (3) Terylene $\left[\text{---OCH}_2\text{---CH}_2\text{---C(=O)---}\text{C}_6\text{H}_4\text{---C(=O)---} \right]_n$ | (4) PMMA $\left[\text{---CH}_2\text{---}\underset{\text{COOCH}_3}{\overset{\text{CH}_3}{\text{C}}}\text{---} \right]_n$ |

6. Monomer of $\left[\text{---}\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}\text{---CH}_2\text{---} \right]_n$ is –

- | | |
|----------------------|-------------|
| (1) 2-methyl propene | (2) Styrene |
| (3) Propylene | (4) Ethene |



MONOMERS AND POLYMERS

S.N.	Monomer	Polymer	Type of Polymers
1.	$\text{CH}_2=\text{CH}_2$ (Ethylene)	Poly ethene	Addition polymer
2.	$\text{CH}_2=\text{CHCH}_3$ (Propylene)	Poly propylene	Addition homo polymer
3.	$\text{CH}_2=\text{CHCl}$ (Vinyl chloride)	Polyvinyl chloride (PVC)	Homopolymer, chain growth
4.	$\text{CH}_2=\text{CH}-\text{C}_6\text{H}_5$ (Styrene)	Polystyrene (styron)	Addition homo polymer, linear chain
5.	$\text{CH}_2=\text{CH}-\text{CN}$ (Acrylonitrile)	Ployacrylonitrile (PAN) or Orlon	Addition homopolymer
6.	$\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ (1,3 Butadiene) + Styrene	BUNA-S rubbers	Addition copolymer
7.	$\text{CH}_2=\text{CHOCOCH}_3$ (Vinyl acetate)	Poly vinyl acetate (PVA)	Addition homopolymer
8.	$\text{CF}_2=\text{CF}_2$ (Tetrafluoro ethylene)	Teflon	Chain growth homopolymer (Nonstick cookwares)
9.	$\text{CH}_2=\text{C}-\text{CH}=\text{CH}_2$ CH_3 (Isoprene)	Natural Rubber	Additon homopolymer
10.	$\text{CH}_2=\text{C}-\text{CH}=\text{CH}_2$ Cl (Chloroprene)	Neoprene (Artificial Rubber)	Addition homopolymer
11.	Ethylene Glycol + terephthalic acid	Terylene or Dacron (Polyester)	Condensation Copolymer, step growth
12.	Hexamethylene diamine + adipic acid	Nylon-6,6 (Polyamide)	Copolymer, step growth linear
13.	Formaldehyde + urea	Urea formaldehyde resin	Copolymer, step growth
14.	Formaldehyde + Phenol	Bakelite	Copolymer, step growth
15.	Methyl methacrylate $\text{CH}_2=\text{C}-\text{COOCH}_3$ CH_3	Poly methyl meth acrylate (PMMA)	Addition homopolymer
16.	Ethylene Glycol + Phthalic acid 	Glyptal or alkyd resin	Copolymer, linear step growth, thermo plastic
17.	Melamine + formaldehyde	Melamine formaldehyde resin	Copolymer, step growth thermosetting polymer
18.	Hexamethylene diamine + sebasic acid	Nylon - 6,10	Copolymer, step growth linear
19.	Caprolactam	Nylon - 6	Homopolymer, step growth linear

ANSWER KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6				
	Ans.	1	2	4	3	3	1				



CHEMISTRY IN EVERY DAY LIFE

6.1 DRUGS

Drugs :

Drugs are the chemicals of low molecular masses which interact with macromolecular target and produce a biological response.

Medicines :

Medicines are the drug which are therapeutic and used for diagnosis, prevention and treatment of diseases.

CLASSES OF DRUGS

(A) Antiseptics :

Which prevent or destroy the growth of the harmful micro organism on living organism externally like wound, cut or skin surface. Common antiseptics are-

Dettol, Savlon, Cetavlon, acriflavin, Iodine, methylene blue, mercurochrome, Furacine, Soframicine

Dettol is a mixture of chloroxylenol and terpineol.

Bithional -It is added to soap to impart antiseptic properties

Iodoform is also used as an antiseptic for wounds. Boric acid in dilute aqueous solution is weak antiseptic for eyes.

(B) Disinfectants :

The chemical compounds capable of completely destroying the micro organism on non-living objects are termed as disinfectants. These are toxic to living tissues.

These are utilized for sterilization of floor, toilets instruments and cloths.

Same substance can act as an antiseptic as well as disinfectant by varying the concentration.

eg. 1% solution of phenol in disinfectant while 0.2% solution of phenol is antiseptic.

(C) Analgesics :

The substance which are used to get relief from pain. These are of two types -

(a) Narcotics or habit forming drugs

(b) Non-narcotics or non-addictive

(a) Narcotics : These are alkaloids and mostly opium products, causes sleep and unconsciousness when taken in higher doses.

e.g. Morphine, codeine, heroin

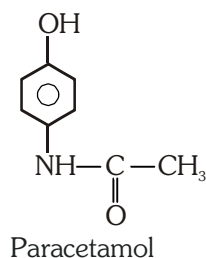
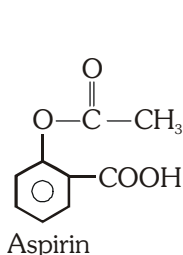
(b) Non-narcotics : Analgesics belonging to this category are effective antipyretics also.

e.g. Aspirin, Novalgin, Ibuprofen and Naproxen

(D) Antipyretics :

To bring down the body temp. in high fever are called antipyretics.

e.g - (a) Aspirin, (b) Analgin (Novalgin), (c) Paracetamol, (d) Phenacetin



(E) Antimalarials :

Drug which is used to prevent or cure malaria.

e.g. Quinine, Chloroquine, Paraquine and Primaquine etc.

(F) Tranquilizers :

The chemical substances which acts on the central nervous system and has a calming effect.

Since these are used for mental diseases so are known as psychotherapeutic drugs.

They are of two types - (a) Sedative or hypnotics (b) Mood elevators

(a) **Sedative** : Reduce nervous tension and promote relaxation. e.g. Reserpine, barbituric acid and its derivatives as luminal, seconal & veronal.

(b) **Mood elevators or Antidepressants** : A drug used for treatment of highly depressed patient, who has lost confidence.

e.g. Benzedrine (amphetamine), Iproniazid and phenelzine

Chlordiazepoxide and meprobamate are relatively mild tranquilizers suitable for relieving tension.

(G) Anesthetics :

These are chemical substances used for producing general or local insensibility to pain and other sensation.

These are of two types (a) General (b) Local

(a) **General** : - Produce unconsciousness and are given at the time of major surgical operations.

e.g. - Gaseous form → Nitrous oxide, ethylene, cyclopropane etc.

Liquid form → Chloroform, divinyl ether and sodium pentothal etc.

(b) **Local anaesthetics**: Produce loss of sensation on a small portion of the body. It is used for minor operations.

e.g. Jelly form → Oxylocain

Spray form → Ethyl chloride

Injection form → Procain

(H) Antibiotics : Initially antibiotic were the chemical substances produced from some micro organism (fungi bacteria or mold) and are used to inhibit the growth or even destroy micro organism.

But now, antibiotics are substances produced wholly or partially by chemical synthesis which in low concentrations inhibits the growth or destroy micro-organism by intervening in their metabolic processes.

These are effective in the treatment of infections diseases.

The range of bacteria or other micro-organisms that are affected by a certain antibiotic is expressed as its spectrum of action.

Three types of spectrum of action :

(i) **Broad spectrum antibiotics** – Antibiotics which kill or inhibit a wide range of gram-positive and gram-negative bacteria. e.g. Ofloxacin, Ampicillin, Amoxycillin, Chlorapheniol

(ii) **Narrow spectrum antibiotics** – Those effective mainly against gram-positive or gram-negative bacteria are narrow spectrum antibiotics. e.g. – penicillin G

(iii) **Limited spectrum antibiotic** – Those effective against a single organism or disease are limited spectrum antibiotics. e.g. – dysidazine – toxic toward certain strain of cancer cell.



Antibiotics have either cidal (killing) effect or a static (inhibitory) effect on microbes. A few example of the two types are –

Bactericidal

Penicillin

Aminoglycosides

Ofloxacin

Bacteriostatic

Erythromycin

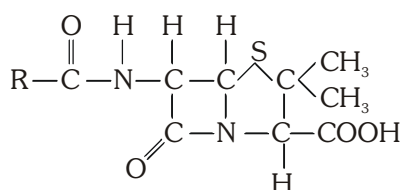
Tetracycline

Chloramphenicol

eg. Salvarsan, Arsphenamine, Prontosil (Sulphanilamide is active part)

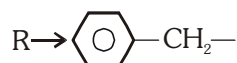
Penicillin - It is highly effective drug for pneumonia, Bronchitis, abscesses, sore throat etc.

Other naturally occurring penicillin -

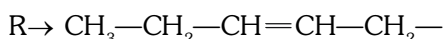


General Structure of Penicillin

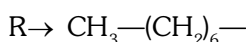
R - May be -



(Penicillin G)



(Penicillin-F)



(Penicillin-K)

Note: Ampicillin & Amoxycillin are synthetic penicillin.

Synthetic antibiotics are Streptomycin, Chloromycetin, Tetracyclins

(I) Antacids

Over production of acid in the stomach causes irritation and pain. In severe cases, ulcers are developed in the stomach. Only treatment for acidity was administration of antacids, such as sodium hydrogencarbonate or a mixture of aluminium and magnesium hydroxide. However, excessive hydrogencarbonate can make the stomach alkaline and trigger the production of even more acid. Metal hydroxides are better alternatives because of being insoluble, these do not increase the pH above neutrality.

A chemical, histamine, stimulates the secretion of pepsin and hydrochloric acid in the stomach. The drug cimetidine (Tegamet), was designed to prevent the interaction of histamine with the receptors present in the stomach wall. This resulted in release of lesser amount of acid. Other e.g. – Ranitidine (Zantac)

(J) Antihistamine

Histamine is responsible for the nasal congestion associated with common cold and allergic response pollen.

Synthetic drugs, brompheniramine (Dimetapp) and terfenadine (Seldane), act as antihistamines. They interfere with the natural action of histamine by competing with histamine for binding sites of receptor where histamine exerts its effect.

Ques. : Why do antihistamines not affect the secretion of acid in stomach ?

Ans. : Reason is that antiallergic and antacid drugs work on different receptors.



6.2 ARTIFICIAL SWEETENING AGENTS

Natural sweeteners, e.g., sucrose add to calorie intake and therefore many people prefer to use artificial sweeteners. Ortho-sulphobenzimide, also called saccharin, is the first popular artificial sweetening agent. It is about 550 times as sweet as cane sugar. It is excreted from the body in urine unchanged. It appears to be entirely inert and harmless when taken. Some other commonly marketed artificial sweeteners and their relative sweetness value in comparison to canesugar is :-

Artificial Sweetner	Sweetness value in Comparison to cane sugar
Aspartame	100
Saccharin	550
Sucralose	600
Alitame	2000

6.3 FOOD PRESERVATIVES

Food preservatives prevent spoilage of food due to microbial growth. The most commonly used preservatives include table salt, sugar, vegetable oils and sodium benzoate. Sodium benzoate is used in limited quantities and is metabolised in the body. Salts of sorbic acid and propanoic acid are also used as preservatives.

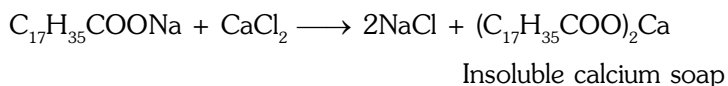
6.4 CLEANSING AGENTS

These are soaps and synthetic detergents. These improve cleansing properties of water. These help in removal of fats which bind other materials to the fabric or skin.

6.4.1 Soaps

Soaps are sodium or potassium salts of long chain fatty acids, e.g., stearic, oleic and palmitic acids. Soaps containing sodium salts are formed by heating fat (i.e., glyceryl ester of fatty acid) with aqueous sodium hydroxide solution. This reaction is known as saponification.

Soap does not work in hard water due to presence of calcium and magnesium ion in hard water. These ions form insoluble calcium & magnesium soap respectively.



These insoluble soap separate as scum in water and are useless as cleansing agent.

Types of soaps

- Toilet soaps • Transparent soaps • Medicated soaps • Shaving soaps • Laundry soaps

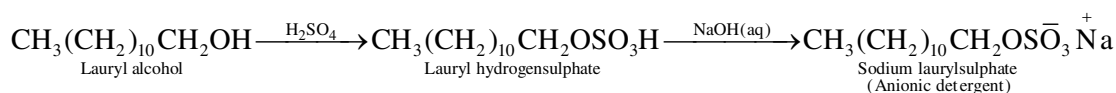
6.4.2 Synthetic Detergents

Synthetic detergents are cleansing agents which have all the properties of soaps, but which actually do not contain any soap. These can be used both in soft and hard water as they give foam even in hard water.

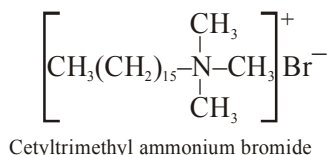
Synthetic detergents are mainly classified into three categories:

- (i) Anionic detergents (ii) Cationic detergents and (iii) Non-ionic detergents

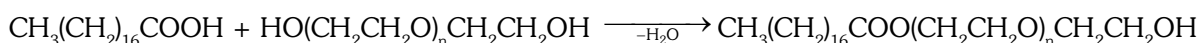
- (i) **Anionic Detergents:** Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons. Alkyl hydrogensulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents. The anionic part of the molecule is involved in the cleansing action. Mostly used for household work and in toothpastes.



- (ii) **Cationic Detergents:** Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Cationic part possess a long hydrocarbon chain and a positive charge on nitrogen atom. Hence, these are called cationic detergents. Cetyltrimethylammonium bromide is a popular cationic detergent and is used in hair conditioners.



- (iii) **Non-ionic Detergents:** Non-ionic detergents do not contain any ion in their constitution. One such detergent is formed when stearic acid reacts with polyethyleneglycol.



Liquid dish washing detergents are non-ionic type.

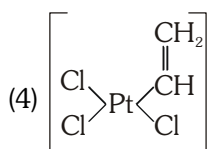
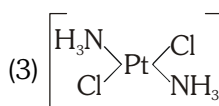
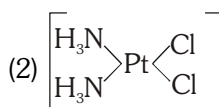
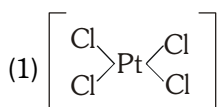
GOLDEN KEY POINTS

- Aspirin is used to prevent heart attacks besides being antipyretic and analgesic agents.
- Derivatives of barbituric acid, viz. veronal, amytal, nembutal, luminal and seconal are hypnotic tranquillizer while meprobamate equanil, valium and serotonin are non-hypnotic tranquillizers.
- Soaps, detergents and phospholipids are called surfactants since they lower the surface tension of water.
- All surfactants consist of two characteristic groups, i.e., apolar head group which is water-soluble (hydrophilic group) and a non-polar hydrocarbon tail which is oil-soluble (lyophilic or lipophilic group).
- Sodium soaps are hard while potassium soaps are soft. Therefore, washing soaps are mostly sodium soaps while liquid soaps having creams and toilet soaps are potassium salts.
- Unlike soaps, detergents can be used in hard water. The reason being that magnesium and calcium salts of detergents are soluble in water while those of soaps are insoluble in water.
- Aspirin, phenacetin and paracetamol act both as antipyretics and analgesics.
- The alkaloid morphine and its derivatives such as codeine (morphine methyl ether) and heroin (morphine diacetate) are important narcotic analgesic.
- Aspirin is a non-narcotic analgesic but is toxic to liver. It also undergoes hydrolysis in the stomach producing salicylic acid which causes bleeding from the stomach wall. Therefore, other non-narcotic analgesics such as naproxen, ibuprofen and diclofenac sodium or potassium are preferred to aspirin.
- Enovid E which is a mixture of norethindron (a progestogen) and ethynysestradiol (an estrogen) is the most commonly used oral contraceptive.
- AZT (3'-Azido-3-deoxythymidine) is used against AIDS i.e. HIV-infections.
- Sulpha drugs are effective against bacterial infections.
- Ciprofloxacin and norfloxacin are quinolone based antibacterial drugs.
- Artificial sweetners have no caloric value and hence are useful for diabetic persons.

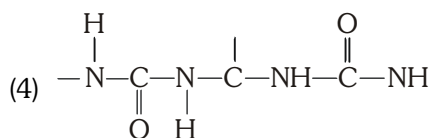
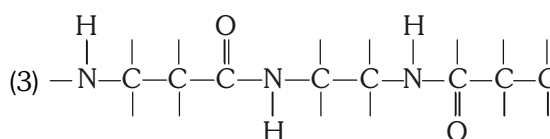
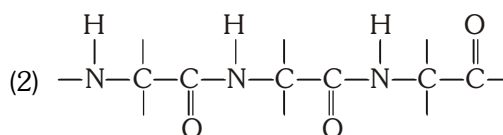
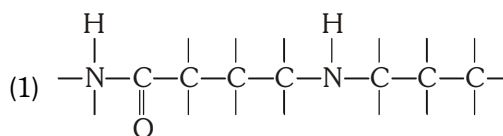


EXERCISE-I (Conceptual Questions)**BIOMOLECULES**

- The nitrogenous base having two possible hydrogen bonding sites is –
 (1) Thymine (2) Cytosine
 (3) Guanine (4) None
- The correct statement in respect of protein haemoglobin is that it –
 (1) Maintains blood sugar level
 (2) Acts as an oxygen carrier in the blood
 (3) Forms antibodies and offers resistance to diseases
 (4) acts as a catalyst for biological reactions
- A sequence of how many nucleotides in messenger RNA makes a codon for an amino acid ?
 (1) 4 (2) 1
 (3) 2 (4) 3
- The hormone that helps in the conversion of glucose to glycogen is –
 (1) Bile acids (2) Adrenaline
 (3) Insulin (4) Cortisone
- The helical structure of protein is stabilized by –
 (1) Hydrogen bonds (2) ether bonds
 (3) peptide bonds (4) dipeptide bonds
- Which of the following is considered to be an anticancer species



7. Which of the following structures represents the peptide chain –



8. Which functional group participates in disulphide bond formation in proteins –
 (1) Thioether (2) Thiol
 (3) Thioester (4) Thiolactone
9. The cell membranes are mainly composed of –
 (1) Phospholipids (2) Proteins
 (3) Fats (4) Carbohydrates
10. Which is simplest amino acid –
 (1) Alanine (2) Asparagine
 (3) Glycine (4) Tyrosine
11. Which of the following biomolecules is insoluble in water –
 (1) α -Keratin (2) Haemoglobin
 (3) Ribonuclease (4) Adenine
12. Which one of the following statements is true for protein synthesis (translation) –
 (1) Amino acids are directly recognized by m-RNA
 (2) The third base of the codon is less specific
 (3) Only one codon codes for an amino acid
 (4) Every t-RNA molecule has more than one amino acid attachment site



- 13.** The presence or absence of hydroxy group on which carbon atom of sugar differentiates RNA and DNA ?
 (1) 3rd (2) 4th (3) 1st (4) 2nd
- 14.** The change in the optical rotation of freshly prepared solution of glucose is known as :-
 (1) tautomerism
 (2) racemisation
 (3) specific rotation
 (4) mutarotation
- 15.** Synthesis of each molecule of glucose in photosynthesis involves :-
 (1) 18 molecules of ATP
 (2) 10 molecules of ATP
 (3) 8 molecules of ATP
 (4) 6 molecules of ATP
- 16.** Which one of the following bases is not present in DNA ?
 (1) Cytosine (2) Thymine
 (3) Quinoline (4) Adenine
- 17.** Lysine; $\text{H}_2\text{N}-(\text{CH}_2)_4-\underset{\text{NH}_2}{\text{CH}}-\text{COOH}$ is :-
 (1) α -Amino acid
 (2) γ -amino acid
 (3) Amino acid synthesised
 (4) β -Amino acid
- 18.** In fibrous protein, polypeptide chains are held together by :-
 (1) Vander waals forces
 (2) Disulphide linkage
 (3) Electrostatic forces attraction
 (4) None of these
- 19.** Which is correct in following –
 (1) Monosaccharides also known as sugars
 (2) Polysaccharides are non sugars
 (3) Maltose and Lactose are reducing sugar
 (4) All of these
- 20.** Structure of glycogen is similar to :-
 (1) Alylose (2) Amylopectin
 (3) Cellulose (4) Glucose
- 21.** Which of the following gives osazone different from the other three :-
 (1) Glucose (2) Mannose
 (3) Galactose (4) Fructose
- 22.** Anomers of glucose (α -form & β -form) are differ in the stereochemistry at which carbon –
 (1) C-1 (2) C-2
 (3) C-3 (4) All of these
- 23.** Sucrose in presence of invertase on hydrolysis gave –
 (1) Glucose (2) Fructose
 (3) Ethyl alcohol (4) 1 & 2 both
- 24.** Which of the following B group vitamins can be stored in our body.
 (1) Vitamin B₁ (2) Vitamin B₂
 (3) Vitamin B₆ (4) Vitamin B₁₂
- 25.** Which of the following are polysaccharides –
 (a) Starch (b) cellulose
 (c) dextrans (d) glycogen
 (1) a, b & c (2) a, b, d
 (3) a & c (4) a,b, c, d
- 26.** Cellulose can not be tested by followings –
 (1) Fehling's solution (2) Tollen's reagent
 (3) Both of these (4) None of these
- 27.** On hydrolysis of proteins, the product is/are –
 (1) Amino acids (2) Peptides
 (3) Enzymes (4) 1 & 2 both
- 28.** Which of the following do not have hemiacetal group:-
 (1) Fructose (2) Maltose
 (3) Sucrose (4) Glucose
- 29.** In amino acids, more number of amino than carboxyl groups makes it –
 (1) acidic (2) Basic
 (3) Neutral (4) None of these
- 30.** Which amino acids are called non essential –
 (1) those which can be synthesized in the body.
 (2) those which have more amino groups as compared to carboxyl groups
 (3) those which have equal number of amino acid and carboxyl groups
 (4) None of these



- 31.** Which of the following is not essential amino acid –
 (1) Serine (2) Lysine
 (3) Threonine (4) Tryptophan
- 32.** In acidic & alkaline solution amino acids exists as a –
 (1) Positive ion & negative ion respectively
 (2) Negative ion & positive ions respectively
 (3) Neutral in both medium
 (4) None of these
- 33.** In which of following shapes are found in tertiary structure of proteins –
 (1) Fibrous (2) Globular
 (3) Both of these (4) None of these
- 34.** The example of globular protein is
 (1) Silk (2) Collagen
 (3) Haemoglobin (4) All of these
- 35.** If a native protein is subjected to physical or chemical treatment which may disrupt its various forms without affecting its primary structure, are called –
 (1) Inactive protein
 (2) Denatured protein
 (3) Both of these
 (4) None of these
- 36.** The coagulation of egg protein while boiling of egg is called –
 (1) Reversible protein denaturation
 (2) Irreversible protein denaturation
 (3) Renaturation
 (4) None of these
- 37.** An enzyme molecule may contain protein and non-protein part. Non-protein part is known as:-
 (1) Holoenzyme (2) Cofactor
 (3) Inverted enzyme (4) None of these
- 38.** Cofactor which gets attached to the enzyme at the time of reaction are known as
 (1) Coenzymes (2) Apoenzyme
 (3) Prothetic group (4) None of these
- 39.** Mainly DNA is localized in –
 (1) Cytoplasm (2) Nucleus
 (3) Mitochondria (4) Chloroplasts
- 40.** RNA contains following pyrimidine bases –
 (a) Thymine (b) Uracil
 (c) Cytosine (d) Adenine
 (1) b & c (2) a, b, c
 (3) a, b, d (4) All of these
- 41.** DNA molecules can duplicate themselves-called –
 (1) Replication
 (2) Translation
 (3) Transcription
 (4) None of these
- 42.** Which of the following carbohydrates are branched polymer of glucose.
 (1) Glycogen (2) Amylopectin
 (3) Cellulose (4) Both (1) & (2)
- 43.** Vitamin K
 (1) Is phyloquinone
 (2) Soluble in oils and fats
 (3) Deficiency lenthens the blood clotting
 (4) All of these
- 44.** Which of the following is not an amino acid
 (1) Histidine (2) Benzidine
 (3) Alanine (4) Proline
- 45.** Vitamin C is called :
 (1) Antisterility (2) Antiscurvy
 (3) both of these (4) None of these
- 46.** Reducing sugars are one which :
 (1) reduce fehling's solutions
 (2) not reduce tollen's reagent
 (3) Have bonded aldehydic or ketonic groups
 (4) All of these
- 47.** Multiple deficiencies caused by lack of more than one vitamin are more common in human beings. This condition of vitamin deficiency is known as
 (1) avitaminosis (2) xerophthalmia
 (3) convulsions (4) None of these



48. Which vitamin is synthesized in human body from carotene

- (1) Vitamin-A (2) Vitamin-C
(3) Vitamin-K (4) All of these

49. Which of the following is correct about H-bonding in nucleotide –

- (1) A-T G-C (2) A-G T-C
(3) G-T A-C (4) A-A T-T

POLYMER

50. Which of the following is monomer unit of polystyrene :-

- (1) $-\text{CH}_2-\underset{\text{CN}}{\text{CH}}-$ (2) $-\text{CF}_2-\text{CF}_2-$
(3) $-\text{CH}_2-\underset{\text{Cl}}{\text{CH}}-$ (4) $-\underset{\text{C}_6\text{H}_5}{\text{CH}}-\text{CH}_2-$

51. Weakest intermolecular forces are present in :-

- (1) Neoprene (2) Terylene
(3) Polystyrene (4) Bakelite

52. Thermosetting polymer, Bakelite is formed by the reaction of phenol with :-

- (1) $\text{CH}_3\text{CH}_2\text{CHO}$ (2) CH_3CHO
(3) HCHO (4) HCOOH

53. Which one is classified as a condensation polymer?

- (1) Teflon (2) Acrylonitrile
(3) Dacron (4) Neoprene

54. Novolac is a :

- (1) linear polymer of urea and formaldehyde
(2) crosslink polymer of urea and formaldehyde
(3) linear polymer of phenol and formaldehyde
(4) crosslink polymer of phenol and formaldehyde

55. Which of the following is not a semisynthetic polymer.

- (1) cis-polyisoprene (2) cellulose nitrate
(3) cellulose acetate (4) vulcanised rubber

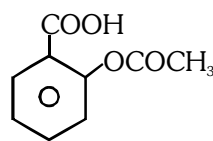
CHEMISTRY IN EVERYDAY LIFE

56. Aspirin is also known as –

- (1) Methyl salicylic acid (2) acetyl salicylate
(3) Methyl salicylate (4) Acetyl salicylic acid

57. Paracetamol is :-

- (1) Analgesic (2) Antipyretic
(3) Both (4) Antiseptic



58. is used as

- (1) Antiseptic (2) Analgesic
(3) Antibiotic (4) Micro organism

59. Which among the following is a tranquilizer ?

- (1) Equanil (2) promethazine
(3) Omeprazole (4) Cimetidine

EXERCISE-I (Conceptual Questions)

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	4	3	1	2	2	2	1	3	1	2	4	4	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	1	2	4	2	3	1	4	4	4	3	4	3	2	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	1	3	3	2	2	2	1	2	1	1	4	4	2	2
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	
Ans.	1	1	1	1	4	1	3	3	3	1	4	3	2	1	



EXERCISE-II(Assertion & Reason)

Directions for Assertion & Reason questions

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions you are required to choose any one of the following four responses.

- (A) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
(B) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
(C) If Assertion is True but the Reason is False.
(D) If both Assertion & Reason are false.

1. **Assertion :-** D-(+) Glucose and L-(-) fructose are enantiomers.
Reason :- Glucose molecule is mirror image of fructose molecule.
(1) A (2) B (3) C (4) D
2. **Assertion :-** Teflon has high thermal stability and chemical inertness.
Reason :- Teflon is highly cross-linked polymer.
(1) A (2) B (3) C (4) D
3. **Assertion :-** Polypropylene is an addition polymer.
Reason :- The monomer unit of polypropylene is $\text{CH}_3\text{-CH=CH}_2$
(1) A (2) B (3) C (4) D
4. **Assertion :-** Carboxypeptidase is an exopeptidase.
Reason :- It cleaves the N-terminal bond.
(1) A (2) B (3) C (4) D
5. **Assertion :-** Natural rubber is cis-1,4-polyisoprene.
Reason :- Isoprene is 2-methyl-1,3-butadiene.
(1) A (2) B (3) C (4) D
6. **Assertion :-** Maltose is composed of galactose.
Reason :- Glucose and galactose differ from C_3 position.
(1) A (2) B (3) C (4) D
7. **Assertion :-** β -pleated sheet structure of protein shows maximum extension.
Reason :- Intermolecular hydrogen bonding is present in them
(1) A (2) B (3) C (4) D
8. **Assertion :-** All enzymes are made up of proteins which have three dimensional structure.
Reason :- Secondary structure of protein are sequence of aminoacids.
(1) A (2) B (3) C (4) D
9. **Assertion :-** Melamine resin has secondary amine functionality.
Reason :- Melamine resin is condensation polymer of melamine and acetaldehyde.
(1) A (2) B (3) C (4) D
10. **Assertion :-** Sucrose and saccharin have nearly same sweetness index.
Reason :- Both compounds are the component of carbohydrate.
(1) A (2) B (3) C (4) D
11. **Assertion :-** Glucose does not give 2, 4-DNP test.
Reason :- Glucose does not have free carbonyl group.
(1) A (2) B (3) C (4) D
12. **Assertion :-** Tryptophan is less basic than Histidine
Reason :- Tryptophan has sp^3 hybridised nitrogen but Histidine has sp^2 hybridisation.
(1) A (2) B (3) C (4) D
13. **Assertion :-** Bakelite is a thermosetting polymer.
Reason :- It has highly branched structure.
(1) A (2) B (3) C (4) D
14. **Assertion :-** Calcium salt of fatty acid can be used as soap.
Reason :- They are water soluble.
(1) A (2) B (3) C (4) D



15. **Assertion :-** Aspirin is used to reduce the chance of heart attack.
Reason :- Aspirin increase the rate of prostaglandin synthesis.
 (1) A (2) B (3) C (4) D
16. **Assertion :-** At neutral pH, Tyrosine act as an acid
Reason :- pK_a of phenol is more than 7.
 (1) A (2) B (3) C (4) D
17. **Assertion :-** Antihistamine does not effect acid secretion of stomach.
Reason :- Antacid and antihistamine acts on different receptors.
 (1) A (2) B (3) C (4) D
18. **Assertion :-** Glucose reacts with Br_2 to form saccharic acid.
Reason :- Acid will be formed by oxidation of alcohol with Br_2 .
 (1) A (2) B (3) C (4) D
19. **Assertion :-** Non competitive inhibitors alters the active site of enzymes.
Reason :- Non competitive inhibitors always bind with active site.
 (1) A (2) B (3) C (4) D
20. **Assertion :-** Generally RNA are single stranded.
Reason :- They interact with amino acids.
 (1) A (2) B (3) C (4) D
21. **Assertion :-** Natural Rubber has elastic property.
Reason :- It has linear structure.
 (1) A (2) B (3) C (4) D
22. **Assertion :-** Cimitidine is an antacid
Reason :- It increases the interaction of histamine with receptors present in stomach wall.
 (1) A (2) B (3) C (4) D
23. **Assertion :-** α – glucose has lesser melting point than β -glucose.
Reason :- β – glucose is more thermodynamic stable.
 (1) A (2) B (3) C (4) D
24. **Assertion :-** Sucrose is dextrorotatory but its aqueous solution is laeverotatory.
Reason :- Dextro rotation of glucose is less than laevo rotation of fructose.
 (1) A (2) B (3) C (4) D
25. **Assertion :-** Novolac on heating with formaldehyde gives bakelite.
Reason :- Bakelite is thermosetting polymer and an infusible solid.
 (1) A (2) B (3) C (4) D

EXERCISE-II (Assertion & Reason)

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	2	1	2	4	2	3	3	4	1	3	2	4	3
Que.	16	17	18	19	20	21	22	23	24	25					
Ans.	2	4	4	3	2	2	3	2	1	2					

